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Technical paper

COMPARISON OF GREENHOUSE GAS EMISSION PROJECTIONS

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I. SCOPE

1. This technical paper compares information in national communications on emission projections by Parties included in Annex I to the Convention (Annex I Parties) with projections provided by other institutions through to the year 2010. For the comparison, the information was aggregated over CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 for Annex I Parties, including separately Parties included in Annex II to the Convention (Annex II Parties) and Parties with economies in transition (EITs).

2. Projections reported by Annex I Parties in their national communications and additional information provided during in-depth reviews were compared with information from the following studies and sources of information (for references see annex below):

(a) Greenhouse gas emission projections included in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios, 2000;

(b) Greenhouse gas emission projections of the World Energy Outlook 2000 of the International Energy Agency (IEA);

(c) Greenhouse gas emission projections based on information made available by the Organisation for Economic Co-operation and Development (OECD) in 2000;

(d) Greenhouse gas emission projections based on information available from the Energy Information Administration (EIA) (2000) and the Environmental Protection Agency (EPA) (2000) of the United States of America;

(e) Greenhouse gas emission projections based on information available from the Directorate General for Energy and the Directorate General for Environment (1998-2000).

3. A draft of this paper was made available as a working paper at the workshop on the preparation of national communications from Annex I Parties held at Bonn, from 28 February to 2 March 2001. The experts attending the workshop were invited to provide technical comments by 2 April 2001. No such comments were received.

II. METHODOLOGY

4. Greenhouse gas emission projections from different studies are based on different assumptions and calculation methods and cover different gases and sectors; they are, therefore, difficult to compare. This technical paper aims to compare a set of possible future emission paths for groups of countries based on information from various studies, with a similar emission path based on projections provided by Parties. In order to perform a comparison or aggregation, it was necessary to make various additional assumptions, for example, on missing gases or countries.

5. No attempt has been made to assess the assumptions used in the original studies. Also, no new scenarios have been developed. This technical paper only compiles information on projected emissions found in other studies.

6. The regional coverage used and reported in the original studies was in some cases not directly comparable to the groups of countries listed in the Convention, namely Annex I, Annex II and EIT Parties. It was therefore necessary to adjust the data to ensure consistency among groups of countries. If the original information was only available for a specific group

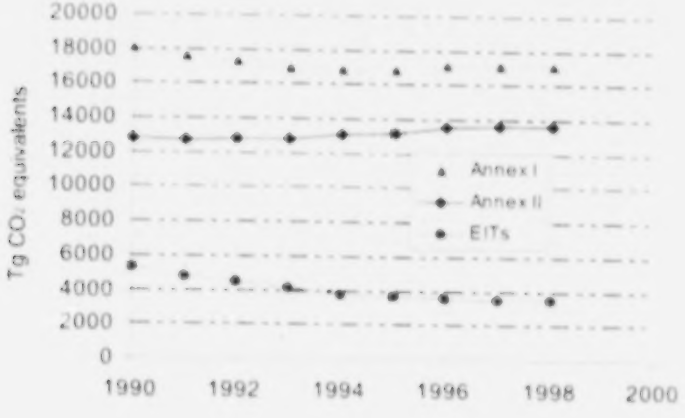
of countries, it was assumed that the growth pattern of the emissions of this group would apply to each individual country.

7. Projections from Parties and all other studies were normalized to inventory data for 1998 as reported by Annex I Parties to the secretariat. If emissions had not yet been reported for recent years, they were assumed to be equal to the emissions for the last reported year. Emission growth rates as provided by Parties and in the original studies were applied to the reported inventory data for the year 1998 to form possible future emission paths. An exception was made for EIT Parties, since the inventory trend was lower compared to the trend used in the projections. Constant emissions of EIT Parties were assumed from 1998 to 2000 for those paths where applying this methodology would have further decreased emissions of EITs in that time period. The use of absolute figures was avoided, since in almost all cases, absolute emissions used as a basis for the projections did not coincide with the inventory emission estimates, even when the coverage of gases and countries was the same. The approach used in this paper avoids discontinuities in the emission paths from 1990 through to 2010, which would normally occur when combining inventory and projections data from different sources.

8. This technical paper compares possible future greenhouse gas emissions of Annex I Parties with emissions in 1990. This is not consistent with the base year selected by EITs under the Convention or with the base year for gases such as HFCs, PFCs and SF_6, which may vary between 1990 and 1995. Total emissions of EITs in their selected base year (1990 or another base year or period depending on the country) are 3 per cent higher than their total emissions for 1990. This corresponds to a 1 per cent change in emissions of all Annex I Parties. The choice of the base year for HFCs, PFCs and SF_6 does not make a significant difference to the total emissions of the Annex I Parties.

9. To fill gaps in the coverage of gases in Parties' projections and in the original studies (mostly HFCs, PFCs and SF_6 or if the original study only covered some source categories, for example, only CO_2 from energy), information from one study was used consistently to ensure completeness. The individual emission paths were developed independently, meaning that information about a study, or one scenario of a study, was used only in one emission path. If a gas had not been considered in an original study, emissions of that gas in 2010 were assumed to be equal to emissions in the latest reported year of the national inventory. Emissions or removals from land-use change and forestry were not considered.

Figure 1 Total greenhouse gas emissions of Annex I, Annex II and EIT Parties
(as reported in national emission inventories in Tg CO_2 equivalents)



10. In this technical paper, those projections were chosen which generally assume that no additional policy efforts would be made to reduce emissions. In the case of the IPCC, all six illustrative scenarios were used, although some of the scenarios incorporate non-climate change policy assumptions.

III. RESULTS

A. Emission trends

11. The trends in greenhouse gas emissions as reported by Parties in national inventories are shown in figure 1 and table 1. The data indicate that:

(a) Total emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 for Annex I Parties in the year 2000 are likely to be close to 1990 levels;

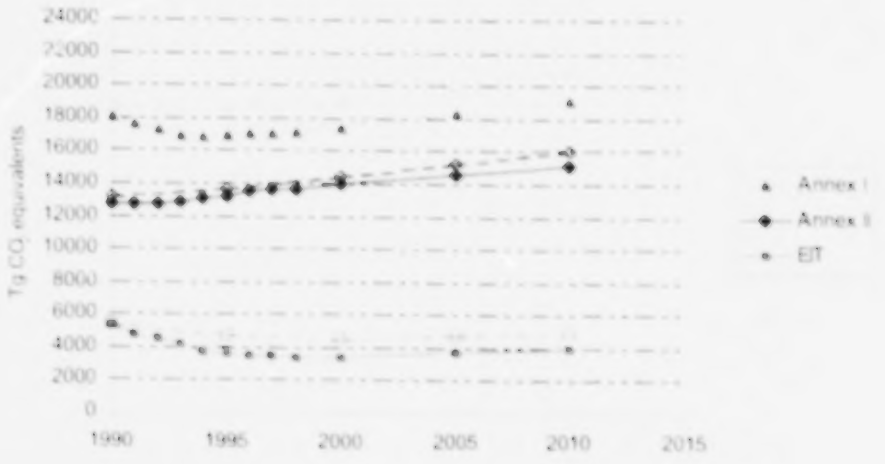
(b) Total emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 for Annex II Parties grew, on average, approximately 1 per cent per year from 1990 to 1998; and

(c) Emissions from EITs in the year 1996, the latest year which all major EITs have reported, were substantially lower than projected in second national communications.

B. Emission trends and projections provided by Parties

12. Projections provided by Parties in second national communications and during in-depth reviews do not coincide with the reported emission inventories. Figure 2 shows the estimated possible emission path according to the methodology described in section II above resulting from the projections provided by the Parties normalized to 1998 inventory data (solid symbols and lines) and also the totals obtained by adding emission projections as

Figure 2 Total GHG emissions for Annex I, Annex II and EIT Parties in Tg CO_2 equivalents (derived from the projections provided by the Parties normalized to 1998 inventory data (solid symbols and lines) and also the totals obtained by adding emissions projections as received (open symbols and dashed lines))



received (open symbols and dashed lines). The difference is small for Annex II Parties but significant for EITs. At the time the projections for EITs were made, 1995 emissions were assumed to be much higher than they eventually turned out to be. Since the calculations in this study are based on the 1998 inventory values and the projected growth rates, the decline in emissions between 1990 and 1995 is retained until 2010. The percentage increase in emissions of Annex I Parties between 1990 and 2010 using the original absolute projections is about 13 per cent, while using the calculated values in this study, it is about 6 per cent.

C. Possible future emission paths

13. Possible future emission paths are shown in figure 3 in terms of the percentage change in emissions for Annex I, Annex II and EIT Parties from 1990 to 2010 based on projections from Parties and various studies as normalized to 1998 greenhouse gas inventory data submitted by Annex I Parties. The corresponding data are provided in table 2.

14. The data suggest that:

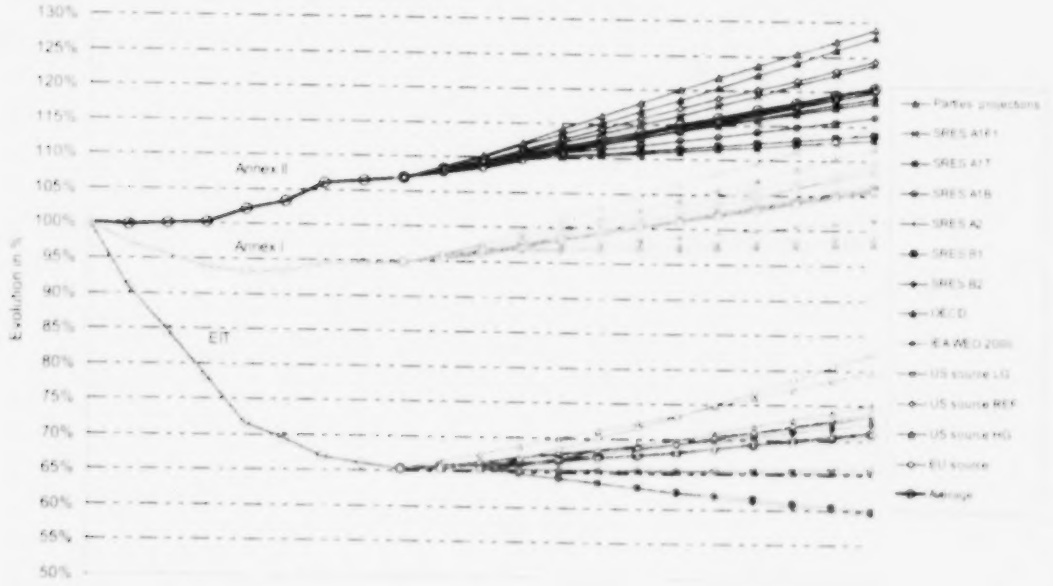
(a) Total emissions of Annex II Parties in the year 2010 are likely to be around 15 per cent to 25 per cent higher than their 1990 levels;

(b) Even with relatively high growth rates, total emissions of EIT Parties are likely to be well below their 1990 levels in the year 2010; and

(c) Total emissions of Annex I Parties in the year 2010 are likely to be between 5 per cent to 10 per cent above 1990 levels.

15. The projected emissions of Annex I Parties in the year 2010 in this study are lower

Figure 3. Percentage change in emissions from 1990 to 2010 according to possible emission paths based on projections from various studies
(for legend see references in annex below)



than estimates developed by the secretariat in 1997. It is very difficult to quantify the extent to which policies adopted by Annex I Parties, new assumptions, for example, economic growth rates, or the use of different methods in the preparation of the projections have contributed to the lower estimates.

16. The future emission paths as presented in figure 3 could be considered as slightly downward biased for several reasons:

(a) Inventory estimates that had not yet been reported, for example, by the Russian Federation (1997 and 1998), Ukraine (1998) and Japan (1998),[1] were assumed to have remained constant at the level of the last reported year, although it is possible that these emissions may have grown in that time period. Emissions of HFCs, PFCs and SF_6, which are expected to have grown since 1990, were not reported by several countries. The total inventory estimates in 1998 - and therefore all calculated future emission paths - could be about four percentage points higher for EITs and one percentage point higher for total Annex I Parties, if high growth for the missing emission estimates for 1998 is assumed;

(b) The IPCC scenarios (six of the thirteen emission paths presented here) take into account policy assumptions and developments in the emission patterns. Two scenarios forecast a further reduction of emissions of EITs between 2000 and 2010;

(c) The World Energy Outlook of the IEA only covers CO_2 emissions from the energy sector. For the purpose of completing the emission path based on information from the IEA, emissions of all other gases and sectors in 2010 were assumed to be equal to greenhouse gas inventory emissions in 1998. Taking an average growth of these other gases and sources as provided in other original studies, this emission path would be around 4 percentage points higher in 2010 for Annex I Parties.

17. Comparing absolute emissions for the years 1990 and 2010 as provided in the original studies would give higher percentage changes than those resulting from this study, which uses emission paths normalized to the inventory estimates. This is mainly because most of the emissions reported by EITs for 1996 were substantially lower than had been assumed in the original studies.

[1] Emissions for 1998 from Japan are now available. At the time of the preparation of the analysis for this technical paper Japan had not yet reported emissions for 1998.

Table 1. Total emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 in Tg CO_2 equivalents as reported by Parties[7]

Annex II									
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
CO_2	10303	10295	10336	10373	10556	10672	10978	11013	11116
CH_4	1362	1351	1345	1326	1328	1338	1327	1325	1313
N_2O	921	920	918	909	953	948	977	977	931
HFC	79	74	81	85	103	121	142	161	181
PFC	56	52	48	47	46	49	52	50	50
SF_6	60	66	68	70	74	81	79	79	80
Total	**12782**	**12757**	**12795**	**12810**	**13059**	**13209**	**13554**	**13605**	**13672**
1990=100%	*100.0%*	*99.8%*	*100.1%*	*100.2%*	*102.2%*	*103.3%*	*106.0%*	*106.4%*	*107.0%*

EITs									
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
CO_2	4162	3763	3512	3240	2942	2846	2729	2692	2650
CH_4	922	865	810	759	712	693	674	663	667
N_2O	179	151	134	119	109	112	113	112	115
HFC	10	10	10	10	10	8	6	7	7
PFC	32	31	30	29	29	28	28	28	29
SF_6	0	0	0	<0.1	<0.1	<0.2	<0.2	<0.3	<0.3
Total	**5304**	**4821**	**4496**	**4157**	**3802**	**3687**	**3551**	**3503**	**3469**
1990=100%	*100.0%*	*90.9%*	*84.7%*	*78.4%*	*71.7%*	*69.5%*	*66.9%*	*66.0%*	*65.4%*

Annex I									
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
CO_2	14465	14058	13848	13613	13498	13518	13707	13704	13766
CH_4	2284	2216	2155	2086	2040	2030	2001	1988	1980
N_2O	1100	1071	1052	1028	1062	1060	1090	1090	1047
HFC	88	84	90	95	112	129	148	168	188
PFC	88	83	78	77	75	78	80	79	80
SF_6	60	66	68	70	74	81	79	80	80
Total	**18086**	**17578**	**17291**	**16967**	**16861**	**16897**	**17105**	**17108**	**17141**
1990=100%	*100.0%*	*97.2%*	*95.6%*	*93.8%*	*93.2%*	*93.4%*	*94.6%*	*94.6%*	*94.8%*

[7] Emission values do not correspond exactly to those reported in other UNFCCC documents since emissions of some sources and gases that had not been reported have been inter- and extrapolated for the purpose of completeness in this technical paper. (See also FCCC/SBI/2000/11 and FCCC/SBI/2000/INF.13).

Table 2 Total emissions in 2010 for emission paths in Tg CO_2 equivalents and relative to 1990

2010	Annex II	% to 1990	EIT	% to 1990	Annex I	% to 1990
Projections by Parties	15154	*118.6%*	3977	*75.0%*	19131	*105.8%*
SRES A1F1	15830	*123.8%*	3780	*71.3%*	19611	*108.4%*
SRES A1T	14449	*113.0%*	3468	*65.4%*	17916	*99.1%*
SRES A1B	14857	*116.2%*	3497	*65.9%*	18355	*101.5%*
SRES A2	15420	*120.6%*	3891	*73.4%*	19311	*106.8%*
SRES B1	14535	*113.7%*	3183	*60.0%*	17717	*98.0%*
SRES B2	15213	*119.0%*	3155	*59.5%*	18368	*101.6%*
OECD	16335	*127.8%*	3889	*73.3%*	20224	*111.8%*
IEA WEO 2000	15402	*120.5%*	3835	*72.3%*	19238	*106.4%*
North American source LG	15325	*119.9%*	3762	*70.9%*	19087	*105.5%*
North American source REF	15895	*124.4%*	3918	*73.9%*	19813	*109.5%*
North American source HG	16491	*129.0%*	4235	*79.8%*	20727	*114.6%*
European source	15334	*120.0%*	4365	*82.3%*	19698	*108.9%*
Average	**15403**	***120.5%***	**3766**	***71.0%***	**19169**	***106.0%***
Minimum	14449	*113.0%*	3155	*59.5%*	17717	*98.0%*
Maximum	16491	*129.0%*	4365	*82.3%*	20727	*114.6%*

Annex

LIST OF DATA SOURCES

Legend	Title	Editor	Year	Source
Parties' projections	Projections provided by Parties in national communications and during in-depth reviews	---	---	http://www.unfccc.int
SRES A1FI SRES A1T SRES A1B SRES A2 SRES B1 SRES B2	Special Report on Emission Scenarios	IPCC	2000	ISBN 0521 80081 1
OECD	Action Against Climate Change and unpublished 2000 update	OECD	1999	ISBN 92-64-17113-4
IEA WEO 2000	World Energy Outlook 2000	IEA	1998	ISBN 92-64-16185-6
US source LG US source REF	International Energy Outlook 2000	EIA	2000	http://www.eia.doe.oiaf/ieo/index.html
US source HG	Emission and projections of Non-CO2 Greenhouse Gases for Developed Countries 1990-2010 DRAFT	EPA	2000	draft report
EU source	World Energy Scenarios	IEPE for EC DG Energy	1999	http://www.shared-analysis.fhg.de
	Options to reduce Methane Emissions	DGXI	1998	http://europa.eu.int/comm/environment/enveco/studies2.htm#9
	Options to reduce Nitrous Oxide Emissions	DGXI	1998	http://europa.eu.int/comm/environment/enveco/studies2.htm#8
	Overview of national programmes to reduce greenhouse gas emissions	ETC/AE for EEA	1999	http://themes.eea.eu.int/binary/topic_8_1999.pdf
	Reduction of the emissions of HFCs, PFCs and SF6 in the European Union	Ecofys for DGXI	1999	http://europa.eu.int/comm/environment/enveco/studies2.htm#3
	Economic evaluation of Emission reductions of HFCs, PFCs and SF6 in Europe	Ecofys for EC DG Environment	2000	http://europa.eu.int/comm/environment/enveco/emission_reductions.pdf
	Environmental signals 2000	EEA	2000	http://themes.eea.eu.int/binary/signals2000.pdf

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